

Entanglement in Marine Debris among Adult Female Northern Fur Seals at St. Paul Island, Alaska in 1991-1999

Masashi KIYOTA^{*1} and Norihisa BABA^{*2}

Sighting surveys of adult female northern fur seals were conducted at St. Paul Island, Alaska in 1991-1999 to monitor the incidence of entanglement in marine debris. Based on the counts of 244,225 individuals, average incidence of entangled females over the entire survey years was estimated at 0.013% and that of females with scars caused by previous entanglement was 0.029%. Trawl nets, monofilament gillnets, polypropylene packing bands, twines and lines and a plastic frame of a laundry detergent box were observed entangled in female seals. Trawl nets were the most numerous, constituting 49% of the entangled debris. Annual incidence of entanglement was higher in 1991 and 1994, but was stabilized at around 0.01% after that. Composition of beach debris indicated recent decrease in trawl nets and packing bands and increase in ropes and lines, possibly related to the trends in commercial fisheries around the breeding island.

Key words: northern fur seal, *Callorhinus ursinus*, Pribilof Islands, marine debris, entanglement

Introduction

The abundance of northern fur seals (*Callorhinus ursinus*) on the Pribilof Islands declined from the late 1950's to 1980's (York, 1987). In spite of the strict protection on the breeding islands, the population has not shown any sign of recovery until now (NMFS 1993; Antonelis *et al.*, 1996). Many factors have been speculated for the cause of the decline; predation, diseases, incidental mortality in fisheries, depleted food resource, contamination by marine pollution and entanglement in marine debris (Trites and Larkin, 1989). Northern fur seals entangled in man-made objects were first observed in the 1930's and increased in the late 1960's when commercial fishing activities increased in the Bering Sea (Fowler, 1987). Investigation of the entanglement among northern fur seals was initiated on land in 1960's in conjunction with the commercial harvest of juvenile males. Similar survey was continued by roundup of juvenile males in 1985-1988 after the cessation of the commercial harvest. Data from these surveys revealed that the entanglement was an important factor contributing the at-sea mortality of juvenile males (Fowler, 1985; Fowler *et al.*, 1990). Since northern fur seals have well-developed polygynous mating system, mortality of adult females caused by entanglement is expected to have more effect on population decline than that of males. However, information on female entanglement has been limited because of the difficulty in conducting research with breeding females, which may cause disturbance to the reproductive colony.

The authors conducted long-term surveys of

entanglement of adult female northern fur seals in marine debris based on sightings at the rookeries on St. Paul Island in 1991-1999. Incidence of entanglement among adult females and its annual changes were estimated from the counts of adult females. Composition of beach debris was also monitored to assess the trends in marine debris around the breeding island.

Materials and Methods

The surveys were conducted on St. Paul Island, Pribilof Islands, Alaska. Island-wide sighting survey of entanglement among adult female northern fur seals was conducted during early reproductive season in July, 1991-1999. The sighting survey was conducted in 14 rookeries on St. Paul Island in conjunction with the counts of adult males to estimate population status (Antonelis, 1992). Adult females congregated in breeding colonies were counted from vantage points either with naked eyes or through binoculars. Only these animals positioned so that their necks were clearly visible were counted. Seals entangled in debris, or those with wounds or scars possibly caused by the previous entanglement, were counted separately. Characteristics of entangled debris, such as position of entanglement, color and type of debris, were recorded when the debris was seen. Total counts and the counts of entangled or scarred individuals were used to estimate the incidence of entanglement among adult females.

To examine the possible seasonal changes in the incidence of entanglement, sighting surveys of adult females were repeated in the southern part of the Reef rookery at three different timings in mid July,

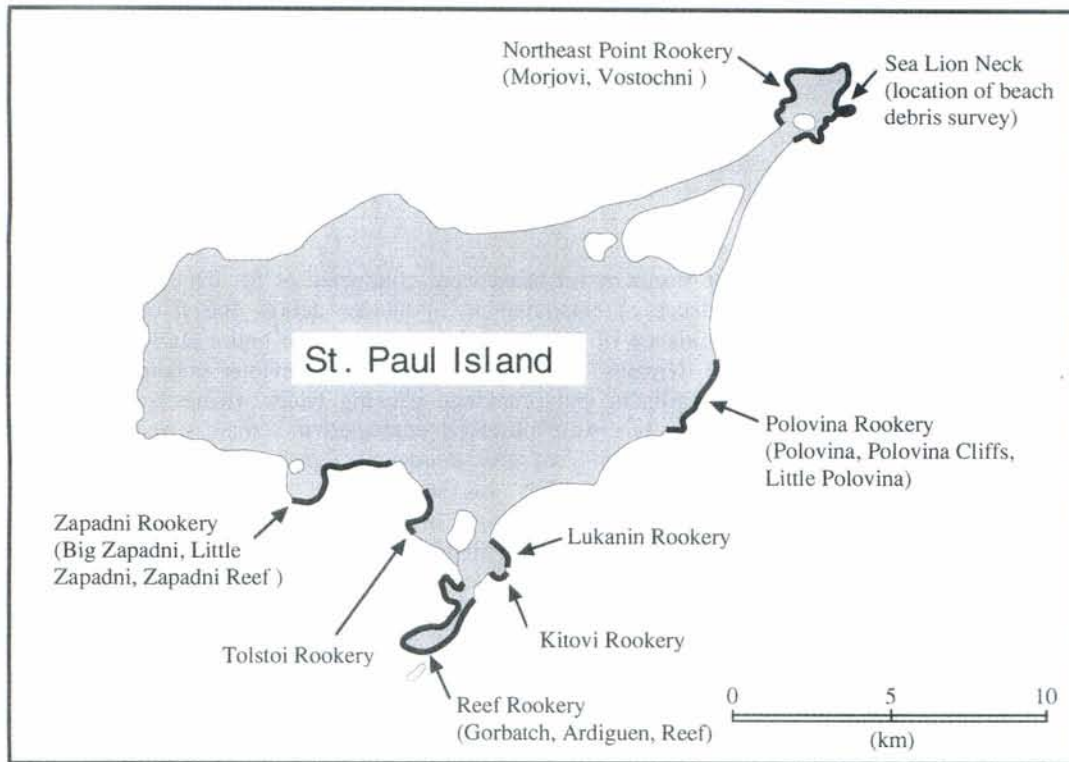


Fig. 1. Map of St. Paul Island showing locations of northern fur seal rookeries and beach clean-up point surveyed in this study. Rookery names in parenthesis indicate the traditional subdivision of the rookery groups.

late July and August in 1992-1998. The survey area was provided with raised wooden catwalks along the breeding aggregation, so the disturbance to fur seals could be minimized by doing the survey from the catwalks.

Survey of beach debris was conducted along the north side of Sea Lion Neck on the North East Point annually in July-August in 1989 and 1991-1998. All the plastic debris washed ashore on the cobble beach (ca. 180m in length) were collected, and type, size and color of each debris were recorded. Percentage composition was calculated for major types of plastic debris. Fragments smaller than 30cm and objects made of rubber or metal were not used for the calculation. All the collected debris were dumped at the garbage disposal site after analysis. Location of fur seal rookeries and the survey points is shown in Fig. 1.

Results

A total of 244,227 adult females were counted through the island-wide surveys over nine years (ranging from 16,009 to 31,638 individuals per year), of which 31 seals were observed entangled. Four additional entangled females were observed during other research activities. Trawl nets (49%, $N=17$) were the most common object entangled with adult females (Table 1). Monofilament gillnets, polypropylene packing bands, twines or lines were also observed, but some of the narrow objects could not be identified when they cut deeply into the fur and flesh. Most (94%) of the entanglement occurred

at the cervical region. Two exceptional cases were observed; one female had a deep bloody wound incised around the abdomen behind the fore flippers possibly caused by line or packing band; the other female put on a plastic frame of a box of laundry detergent at the head.

The observed incidence of entanglement was quite low among female fur seals. Average incidence of entangled females were 0.013%, and that of scarred females was 0.029%. Fig. 2 shows the annual changes in the incidence of entanglement among females. The incidence of entanglement was relatively high in 1991 (0.019%) and in 1994 (0.023%), but it stayed at a low level around 0.01% in later years. The percentage of females either with entangled debris or scars showed higher value in 1991 (0.062%) and in 1994 (0.056%), but was quite stable around 0.04% after 1994.

Seasonal difference in the incidence of entanglement is shown in Fig. 3. The rate of entanglement was lower in mid July compared to the later seasons. But the difference was not significant ($p>0.05$, Kruskal-Wallis test) because of the small sample size and of the low incidence of entanglement.

The observed magnitude of entanglement between rookeries is compared in Table 2. Entangled or scarred females were not observed at Lukanin and Kitovi rookeries throughout the research period. Besides Lukanin and Kitovi rookeries, significant difference in the incidence of entangled and/or scarred individual was not observed between rookeries (χ^2 -test, $p>0.05$).

Table 1. Adult female northern fur seals entangled with marine debris observed during the surveys at St. Paul Island in 1991-1999.

Date	Rookery	Entangled debris	Debris color	Position of entanglement
10/Jul/1991	*Gorbatch	unidentified (line or band)	-	neck
10/Jul/1991	Reef	trawl net	blue-green	neck
13/Jul/1991	Polovina Cliffs	unidentified (line or band)	-	abdomen
13/Jul/1991	Polovina Cliffs	trawl net	green	neck
10/Jul/1992	Little Zapadni	packing band	blue	neck
15/Jul/1992	Vostochni	trawl net	green	neck
16/Jul/1992	Tolstoi	trawl net	green	neck
14/Jul/1993	Big Zap	trawl net	blue	neck
15/Jul/1993	Little Zapadni	trawl net	blue	neck
18/Jul/1993	Morjovi	packing band	black	neck
17/Jul/1994	Vostochni	packing band	white	neck
17/Jul/1994	Vostochni	string or band	-	neck
17/Jul/1994	Vostochni	twine or net	grey	neck
18/Jul/1994	Big Zapadni	trawl net	green	neck
20/Jul/1994	Polovina Cliffs	trawl net	grey	neck
21/Jul/1994	Gorbatch	unidentified (twine?)	green	neck
21/Jul/1994	Reef	trawl net	green	neck
21/Jul/1994	*Reef	string or band	black	neck
13/Jul/1995	Tolstoi	plastic frame	white	head
15/Jul/1995	Polovina Cliff	monofilament gillnet	clear	neck
15/Jul/1995	Little Polovina	twine	pink	neck
1/Aug/1995	*Reef	unidentified (twine?)	-	neck
12/Jul/1996	Tolstoi	unidentified (line or band)	-	neck
16/Jul/1996	Morjovi	trawl net	white	neck
16/Jul/1996	Morjovi	trawl net	grey-green	neck
17/Jul/1996	Reef	monofilament gillnet	clear	neck
14/Jul/1997	Gorbatch	trawl net	green	neck
14/Jul/1997	Reef	trawl net	green	neck
15/Jul/1998	Morjovi	monofilament gillnet	-	neck
15/Jul/1998	Vostochni	string with plastic rings	black	neck
20/Jul/1998	Reef	trawl net	grey	neck
20/Jul/1998	Reef	trawl net	grey	neck
20/Jul/1998	*Reef	twine with two plastic tubes	grey/black	neck
12/Jul/1999	Big Zapadni	trawl net	grey	neck
15/Jul/1999	Vostochni	trawl net	blue	neck

*observed by research activities other than the island-wide survey.

A total of 1,757 plastic debris were collected by the beach clean-up surveys (Table 3). The number of beach debris collected during one survey varied from 93 to 294. Rope, polypropylene packing band, twine and line, trawl net and float were the major types of debris collected (Table 3). Plastic sheets, plastic bottles, buckets and lids, tie-wrap bands with or without numbered tags were classified as 'other

plastics' in Table 3. According to Baba and Kajimura (1992), debris related to fisheries were re-classified into three categories (nets, ropes and lines, packing bands), and annual trends in number and percentage composition of these items were examined combining our results with their data collected at the same location in 1983, 1984, 1986, 1988 and 1990 (Fig. 4). Total number of debris

Table 2. Total number of females counted by the annual island-wide surveys in 1991-1999 with the incidence of entangled or scarred adult females in each rookery group.

Rookery group	Total counts	Entangled		Scarred	
		No.	Rate	No.	Rate
Zapadni	53,190	5	0.009%	16	0.030%
Tolstoi	32,541	3	0.009%	10	0.031%
Reef	61,574	8	0.013%	21	0.034%
Lukanin-Kitovi	17,723	0	0.000%	0	0.000%
Polovina	31,164	5	0.016%	9	0.029%
Northeast Point	48,033	10	0.021%	16	0.033%
Total	244,225	31	0.013%	72	0.029%

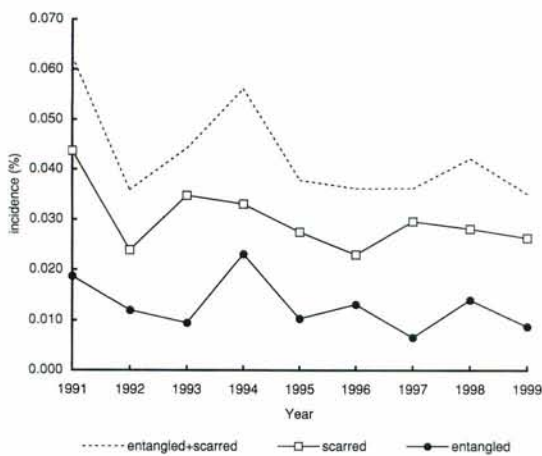


Fig. 2. Annual changes in the incidence of marine debris entanglement among adult female northern fur seals. Percentages of entangled or scarred individuals are shown.

fluctuated greatly year by year since the amount of marine debris deposited on the beach is largely affected by the wind and storm condition, as noticed by Johnson (1990). Nevertheless, number of trawl nets showed steady decrease after 1983 and was stabilized at a low level in the 1990's. The amount of packing bands and ropes and lines on the beach showed great annual fluctuations, but percentage composition indicated decrease in packing bands and increase in ropes and lines.

Discussion

Incidence of entanglement in marine mammals with synthetic debris has been well monitored for young male northern fur seals on the Pribilof Islands since the 1960's. Fowler (1987) reported that the rate of entanglement among juvenile males increased from 0.2% in the 1960's up to 0.7% in 1975. The entanglement rate declined to 0.2% in the late 1990's (Robson *et al.*, 1999). The average entanglement rate among adult females observed in this study was 0.013%, fifteen times lower than that for juvenile males.

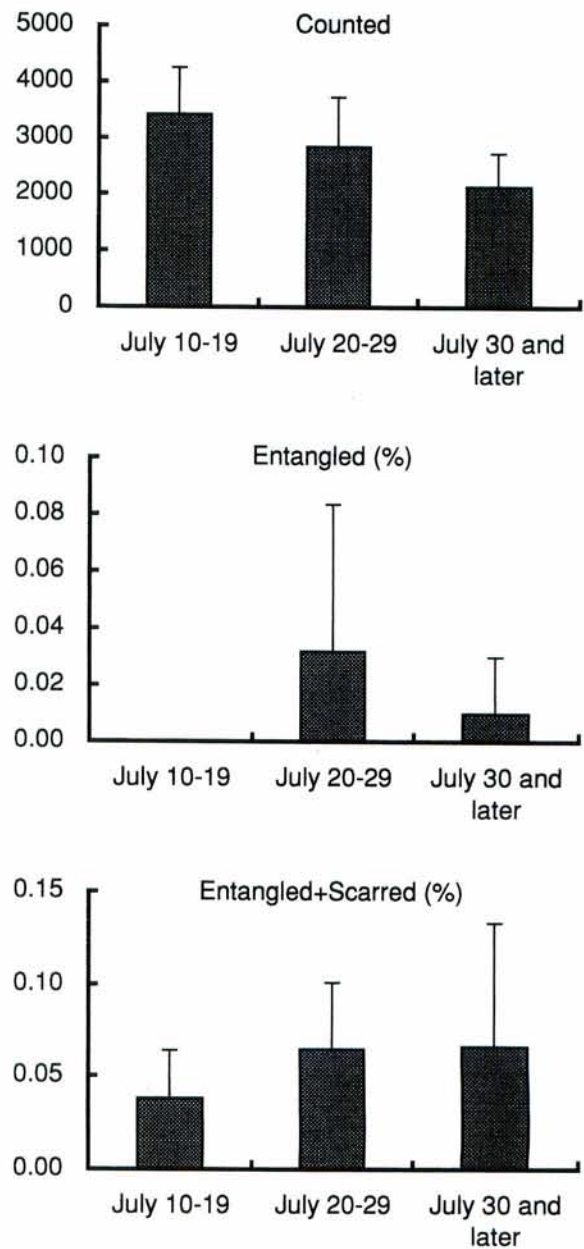
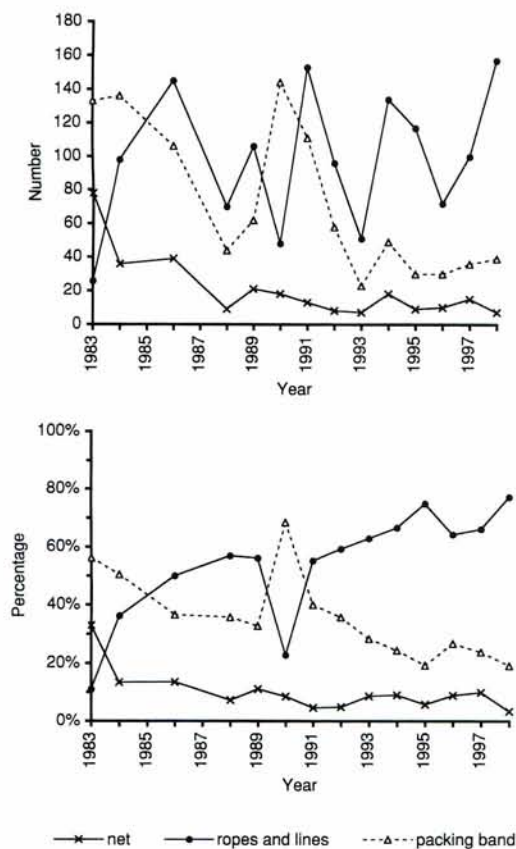


Fig. 3. Seasonal difference in the incidence of entanglement among adult female northern fur seals surveyed at Reef rookery in 1991-1998. Vertical bars indicate standard errors.

Table 3. Number and types of plastic debris collected by the beach clean-up surveys at Sea Lion Neck, St. Paul Island in 1991-1998.

Year	1989	1991	1992	1993	1994	1995	1996	1997	1998	Total
trawl net	20	13	8	7	17	8	8	14	7	102
gill net	1				1					2
other net						1	2	1		4
longline		2			5	1	1		1	10
crab pot						1				1
bait bag		1		2	3	6	1	1	8	22
float		8		6	16	2	13	12	13	70
rope	60	100	59	36	96	62	60	92	109	674
twine and string	46	53	37	15	38	55	12	8	48	312
packing band	62	111	58	23	49	30	30	36	39	438
other plastic	11	6	4	4	4	8	32	26	38	133
Total	189	294	166	93	229	174	159	190	263	1,757

**Fig. 4.** Changes in number (upper panel) and percentage composition (lower panel) of net, lines and ropes, and packing bands deposited on a beach of Sea Lion Neck, St. Paul Island in 1983-1998. Data for 1983, 1984, 1986, 1988 and 1990 are cited from Baba and Kajimura (1992).

The discrepancy in the observed magnitude of entanglement between males and females might be caused by the difference in survey method. Surveys of juvenile males were carried out through commercial harvests and round-ups where small groups of animals were herded and observed by a number of people at a short distance. Entangled individuals were captured, disentangled, and tagged or marked. The sighting surveys adopted in this

study were done basically by one person at a greater distance (usually 5-500m) from the animals. Adult females made dense aggregation in the breeding area so that the miss sighting of entanglement should occur. Probability of overlooking is expected to be higher for the smaller, less conspicuous fragments than such conspicuous fragment as trawl webbings. Robson *et al.* (1996) captured and disentangled male and female seals and calculated composition of entangled debris. Percentage of trawl net in debris disentangled from young males on St. Paul Island in 1992-1994 ranged from 41.2 to 60.4%. The percentage of trawl net among disentangled females was 30% in 1994. These values are quite comparable with those observed for females in this study (49%). The similarity of the debris composition estimated through different survey methods suggests that the missing rate of smaller objects in the sighting survey was not very high. The low incidence of entanglement among adult females in this study seems like an actual phenomenon. Similar sexual difference in entanglement rate was reported for Antarctic fur seals (*Arctocephalus gazella*) by Croxall *et al.* (1990).

Possible cause for the sexual difference in the incidence of entanglement is the difference in behavioral traits related to sex and age. Captive studies demonstrated that fur seals showed interests in floating objects like nets and packing bands and got entangled while playing with them (Yoshida and Baba, 1985; Feldkamp *et al.*, 1988). Since younger animals are more curious to strange objects, they are more likely to be entangled in man-made debris. Age composition of juvenile males (2-5 year) and adult females (4-20+ year) is quite different although their body sizes are similar. Higher proportion of young curious individuals may result in the higher incidence of entanglement in juvenile males. It is known that younger females arrive at the breeding island later in the reproductive season (Gentry, 1998), which may lead to higher entanglement rate in later reproductive season. Moreover, most of juvenile females do not return to the breeding island and stay in the oceanic area until they attain sexual

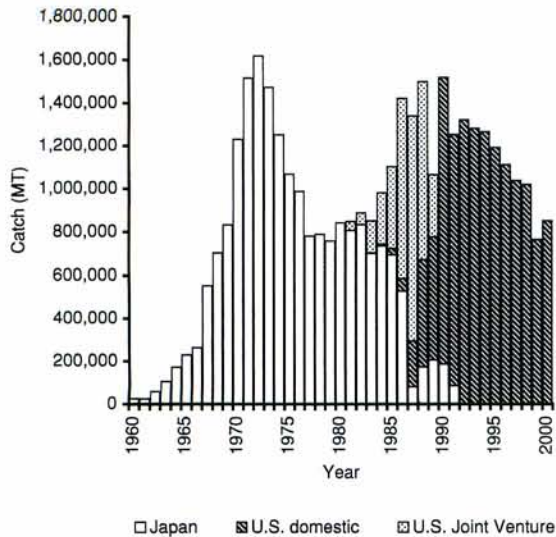


Fig. 5. Catches of walleye pollock from the eastern Bering Sea and Aleutian Islands area by Japanese and U.S. vessels, 1960-1996 (Data from Forrester *et al.* (1978), statistical yearbooks of INPFC and NPAFC, and NMFS website).

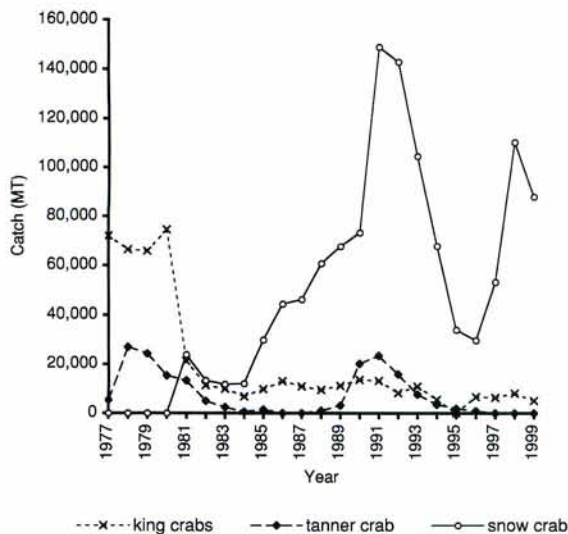


Fig. 6. Catches of crabs from the Bering Sea by U.S. vessels, 1977-1999 (data from Alaska Department of Fish and Game).

maturity (Bigg, 1990). These behavioral differences might cause the lower level of entanglement observed among adult females. Other possibilities, *e.g.*, higher at-sea mortality of entangled females, or longer resting period of entangled males on land during breeding season, could also lead to the apparent lower incidence of entanglement in adult females. Further research is needed to validate these explanations.

Several reports were made on the past incidence of entanglement among female northern fur seals. Bigg (1979) made the first sighting survey of entanglement among females on St. Paul Island in 1978 and reported that 0.16% of females were entangled. Scordino *et al.* (1988) repeated sighting

surveys at two rookeries of St. Paul Island in 1984. Their estimates of entanglement rate ranged from 0.017% to 0.167% (0.03% on average). DeLong *et al.* (1988) observed 16 entangled females through sighting surveys at Tolstoi, Lukanin and Polovina Cliffs rookeries in 1985 and estimated the entanglement rate at 0.15%. Stewart *et al.* (1988) conducted island-wide surveys in 1986 and reported that approximately 0.05% of females were observed to be entangled. These past surveys suggest that the incidence of entanglement among female northern fur seals were higher in the 1970's and 1980's. Similar trends were observed for juvenile males (Robson *et al.*, 1999). The decline in entanglement rate could be attributed to the changes in commercial fisheries in the Bering Sea and to the improvement of disposal of fishery debris under the international agreement such as MARPOL (International Convention for the Prevention of Pollution from Ships) and the London Dumping Convention.

Composition of beach debris indicated recent decrease in nets and polypropylene packing bands and increase in ropes and lines. In the Bering Sea, trawl fishery for walleye pollock (*Theragra chalcogramma*) was initiated by Japanese vessels and showed rapid growth in the 1960's. In the late 1980's, although the Japanese vessels retreated, the fishery increased with the participation of U.S. domestic fishery. The U. S. fishery showed gradual decrease in the 1990's (Fig. 5). The continental shelf area spread to the north of Pribilof Islands provides a good fishing ground of snow crabs (*Chionoecetes opilio*) during winter period. Crab pot fishery for snow crabs made explosive growth in 1990's after the stocks of king crabs (*Paralithodes* spp. and *Lithodes* spp.) and tanner crabs (*C. bairdi*) were depleted by over-exploitation (Fig. 6). St. Paul Island had been developed as a base station for crab fishery since 1993 and many fishing vessels started to enter the port since then. Recent increase in ropes and lines among beach debris might reflect the growth in crab fishery around the island. Bait bags used in crab pots were collected by the beach clean-up in this survey and were actually observed entangled with juvenile males in 1994 and later years (Robson *et al.*, 1996).

The composition of debris entangled among northern fur seals did not completely coincide with that of beach debris nor with trends in commercial fishery. Dominance of trawl webbings in the entangled debris might indicate higher probability of entanglement in nettings. In addition, as typically indicated by a laundry detergent box fitted to a female's head, sources of marine debris are not limited to commercial fisheries. Once plastic litters are disposed of improperly and carried into the sea by rivers or winds, they persist for a long period and may cause various trouble with marine wildlife (Pruter, 1987). Since northern fur seals on the Pribilof Islands have been monitored and managed since 1911, they will provide ideal material for the studies on the impact of marine debris on marine

wildlife population. Long-term monitoring will be important because of the long generation time of fur seals and of the persistent nature of the plastic debris.

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References

- Antonelis, G. 1992: Northern fur seal research techniques manual. *U.S. Dep. Commer. NOAA Tech. Memo. NMFS F/NWC-214*, 47 pp.
- Antonelis, G. A., A. E. York, B. W. Robson, R. G. Towell, and C. W. Fowler. 1996: Population assessment, Pribilof Islands, Alaska. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-69*: 9-29.
- Baba, N., and H. Kajimura. 1992: Fish net debris and beach litter on St. Paul Island, Alaska. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-2*: 82-90.
- Bigg, M. A. 1979: Incidence of adult northern fur seals entangled in debris on St. Paul Island, 1978. Background paper submitted to the 22nd Annual Meeting of the Standing Scientific Committee, North Pacific Fur Seal Commission, 9-13 April 1979, Washington D. C.
- Bigg, M. A. 1990: Migration of northern fur seals (*Callorhinus ursinus*) off western North America. *Can. Tech. Rept. Fish. Aquat. Sci.*, No. 1764. 64 pp.
- Croxall, J. P., S. Rodwell, and I. L. Boyd. 1990: Entanglement in man-made debris of Antarctic fur seals at Bird Island, South Georgia. *Marine Mammal Science*, 6(3): 221-233.
- DeLong, R. L., P. Dawson, and P. J. Gearin. 1985: Incidence and impact of entanglement in netting debris on northern fur seal pups and adult females, St. Paul Island, Alaska. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS F/NWC-146*: 58-68.
- Feldkamp, S. D., D. P. Costa, and G. K. DeKrey. 1989: Energetic and behavioral effects of net entanglement on juvenile northern fur seals, *Callorhinus ursinus*. *Fishery Bulletin*, 87: 85-94.
- Forrester, C. R., A. J. Beardsley, and Y. Takahashi. 1978: Groundfish, shrimp, and herring fisheries in the Bering Sea and Northeast Pacific - historical catch statistics through 1970. *INPFC Bull.*, 37: 1-140.
- Fowler, C. W. 1985: An evaluation of the role of entanglement in the population dynamics of northern fur seals on the Pribilof Islands. In: R. S. Shomura and H. O. Yoshida (eds.), Proceedings of the Workshop on the Fate and Impact of Marine Debris, 26-29 November 1984, Honolulu, Hawaii. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-54*: 291-307.
- Fowler, C. W. 1987: Marine debris and northern fur seals: a case study. *Marine Pollution Bulletin*, 18(6B): 326-335.
- Fowler, C. W., R. Merrick, and J. D. Baker. 1990: Studies on the population level effects of entanglement on northern fur seals. In: R. S. Shomura and M. L. Godfrey (eds.), Proceedings of the Second International Conference on Marine Debris, 2-7 April 1989, Honolulu, Hawaii. *U. S. Dept. Commer., NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-154*: 453-474.
- Gentry, R. L. 1998: Behavior and ecology of the northern fur seal. Princeton University Press, Princeton, N. J. 376 pp.
- Johnson, S. W. 1990: Entanglement debris on Alaskan beaches, 1989. *U. S. Dept. Commer., NWAFC Processed Report 90-10*. 16 pp.
- NMFS. 1993: Final conservation plan for the northern fur seal *Callorhinus ursinus*. Prepared by the National Marine Mammal Laboratory/Alaska Fisheries Science Center, Seattle, Washington, and the Office of Protected Resources/National Marine Fisheries Service, Silver Spring, Maryland. 80 pp.
- Pruter, A. T. 1987: Sources, quantities and distribution of persistent plastics in the marine environment. *Marine Pollution Bulletin*, 18(6B): 305-311.
- Robson, B. W., M. Kiyota, G. A. Antonelis, M. D. Melvidov, and M. T. Williams. 1996: Summary of activities related to northern fur seal entanglement in marine debris. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-69*: 75-79.
- Robson, B. W., R. G. Towell, M. Kiyota, C. M. Stepetin, and G. E. Merculief. 1999: Northern fur seal entanglement studies: St. Paul and St. George Islands, 1997. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS-AFSC-106*: 33-54.
- Scordino, J., H. Kajimura, N. Baba, and A. Furuta. 1988: Fur seal entanglement studies in 1984, St. Paul Island, Alaska. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS F/NWC-146*: 70-78.
- Stewart, B. S., N. Baba, P. J. Gearin, and J. Baker. 1989: Observations of beach debris and net entanglement on St. Paul Island, Alaska. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS F/NWC-174*: 57-60.
- Trites, A. W., and P. A. Larkin. 1989: The decline and fall of Pribilof fur seal (*Callorhinus ursinus*):

- a simulation study. *Can. J. Fish. Aquat. Sci.*, 46:1437-1445.
- York, A. E. 1987: Northern fur seal, *Callorhinus ursinus*, eastern Pacific population (Pribilof Islands, Alaska, and San Miguel Island, California). *U. S. Dep. Commer. NOAA Tech. Rep. NMFS-51*: 9-21.
- Yoshida, K., and N. Baba. 1985: The problem of fur seal entanglement in marine debris. In: R. S. Shomura and H. O. Yoshida (eds.), *Proceedings of the Workshop on the Fate and Impact of Marine Debris*, 26-29 November 1984, Honolulu, Hawaii. *U. S. Dep. Commer. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS-SWFC-54*: 448-452.

アラスカ州セントポール島におけるキタオットセイ成獣雌の海洋廃棄物絡まり, 1991-1999年

清田雅史¹・馬場徳寿²

摘 要

1991年から1999年の間米国アラスカ州セントポール島において、成獣雌キタオットセイの海洋廃棄物絡まりに関する調査を実施した。繁殖初期の7月初旬から8月初旬にかけて、繁殖コロニーにおいて異物絡まり雌と非絡まり雌の計数と絡まり異物の確認を行い、海岸に漂着した海洋廃棄物の種類と量を調べた。成獣雌キタオットセイの絡まり率は1991年と1994年に若干高かったが、1995年以降は0.01%前後で推移した。この9年間における成獣雌の平均絡まり率は0.013%、絡まりに由来する傷をもつ成獣雌の割合は0.029%であった。絡まり異物は、トロール漁網片、刺網片、ひも類、梱包用ポリプロピレンバンド、洗濯洗剤容器のプラスチック枠などで、そのうちトロール漁網片が最も多く49%を占めた。海岸漂着物では、近年トロール漁網片と梱包用ポリプロピレンバンドの割合が低下する一方ロープ類が増加しており、繁殖島周辺における漁業の動向に関連した組成変化が見られた。

¹遠洋水産研究所 (〒424-8633 静岡県清水市折戸5丁目7番3号)

²中央水産研究所 (〒236-8648 神奈川県横浜市金沢区福浦2丁目12番4号)